5. Correlated Noise

Correlated Noise

Claim Term	CMU's Construction	Marvell's Construction
correlated noise **'839 Patent Claims 2 and 5** **'180 Patent Claim 1**	noise with 'correlation' among 'signal samples,' such as that caused by coloring by front-end equalizers, media noise, media nonlinearities, and magnetoresistive (MR) head nonlinearities. **CMU Brf. at 19**	noise having nonzero 'covariance' (see construction of 'covariance' above). **Marvell Brf. at 32-33**

- The Dispute
  - Should "correlated noise" be accorded its ordinary meaning in engineering and statistics (Marvell) or its lay meaning with a list of examples (CMU)?

Claim Language

- Method refers to a generic list of noise types

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2. The method of claim **1** further comprising the step of receiving said signal samples, said signal samples having signal-dependent noise, correlated noise, or both signal-dependent and correlated noise associated therewith.

'839 Patent Claim 2

5. The method of claim **4** further comprising the step of receiving said signal samples, said signal samples having signal-dependent noise, correlated noise, or both signal-dependent and correlated noise associated therewith.

'839 Patent Claim 5

See also '180 Patent Claim 1

Specification

- Patents describe correlated noise using mathematical terms

Correlation-sensitive branch metric. In the most general case, the correlation length is L>0. The leading and trailing ISI lengths are K_l and K_t, respectively. The noise is now considered to be both correlated and signal-dependent. Joint Gaussian noise pdfs are assumed. This assumption is well justified in magnetic recording because the experimental evidence shows that the dominant media noise modes have Gaussian-like histograms. The conditional pdfs do not factor out in this general case, so the general form for the pdf is:

$$\frac{f(r_{i+1}, \ldots, r_{i+L} \mid a_{i-K_l}, \ldots, a_{i+L+K_t})}{f(r_i, r_{i+1}, \ldots, r_{i+L} \mid a_{i-K_l}, \ldots, a_{i+L+K_t})} = \sqrt{\frac{(2\pi)^{L+1} \det C_i}{(2\pi)^{L} \det c_i}} \; \frac{\exp[\underline{N}_i^T C_i^{-1} \underline{N}_i]}{\exp[\underline{n}_i^T c_i^{-1} \underline{n}_i]} \tag{11}$$

’839 Patent 6:36-52

Extrinsic Evidence: Technical Treatises

- Marvell construction identical to statistical meaning
  - Uncorrelated variables have zero covariance
  - Correlated variables have nonzero covariance

If $\mathrm{Cov}(X_1, X_2) = 0$, then the random variables X_1 and X_2 are said to be *uncorrelated*; if $\mathrm{Cov}(X_1, X_2) \neq 0$, then they are *correlated*. Independent random variables are always uncorrelated, but correlated random variables are not necessarily independent in general.

Polyanin and Manzhirov, *Handbook of Mathematics for Engineers and Scientists*, at 1061 (2007) (Marvell Exh. 36)

2.3.2 *Correlation and Covariance*

The second joint *centralized* moment is called the *covariance*, and is denoted by K_{XY}:

$$K_{XY} \triangleq E\{(X - m_X)(Y - m_Y)\}. \quad (2.21)$$

It is easily shown (exercise 3) that

$$K_{XY} \equiv R_{XY} - m_X m_Y. \quad (2.22)$$

The correlation and covariance are each important measures of the interdependence of two random variables. If

$$K_{XY} = 0, \quad (2.23)$$

then X and Y are said to be *uncorrelated*. This terminology results from the fact that $K_{XY}/\sigma_X\sigma_Y$ is referred to as the *correlation coefficient*. If

Gardner, *Introduction to Random Processes with Applications to Signals and Systems*, at 32-33 (1986) (Marvell Exh. 24)

Two random variables are said to be *uncorrelated* if $E(X_iX_j) = E(X_i)E(X_j) = m_im_j$. In that case, the covariance $\mu_{ij} = 0$. We note that when X_i

John G. Proakis, *Digital Communications*, at 35 (3d ed. 1995) (Marvell Exh. 35); *See also* Proakis Decl. at ¶¶ 42-43

CMU's Arguments Fail

- CMU's construction is grounded in its incorrect construction of correlation.

- CMU's list of examples from the specification is not helpful and improper.
  - "[A]lthough the specification often describes very specific embodiments of the invention, we have repeatedly warned against confining the claims to those embodiments." *Phillips*, 415 F.3d at 1323.
  - "This Court has cautioned against limiting the claimed invention to preferred embodiments or specific examples in the specification."
    Texas Instruments, Inc. v. U.S. Int'l Trade Comm'n, 805 F.2d 1558, 1563 (Fed. Cir. 1986).